COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATIO

August, 1946

Keystone View Co.

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FOR AUGUST 1946

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EDITORIALS

DEPARTMENTS

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EDITORIAL

Combustible in Stack Discharge

Developments during the last few years have tended to reduce the amount of combustible in the fly ash with all types of solid fuel firing. With pulverized coal this has been accomplished through improved burner design, insuring better distribution and mixing of the coal and air, and greater turbulence. Also, the downward trend in furnace heat release rates has been helpful. With stoker firing the reinjection of cinders and fly ash from the boiler and economizer passes, which practice is rapidly gaining favor, greatly reduces the combustible in the ash finally discharged.

Such measures have improved economy of operation and affect the color of the stack discharge; but, of course, they have little or no effect on the quantity of ash discharged. This is governed by the character of the coal and the load.

Despite the increasing employment of fly-ash-arresting equipment, the atmospheres of many of our industrial centers are still far from clear. This may be attributable in part to the character of coal available and in part to the relaxation of enforcement in some localities that existed under the stress of war production.

Need for Scrap Critical

According to the American Iron and Steel Institute, a large factor in the present delayed deliveries of steel for heavy equipment is the acute shortage of scrap. In fact, on August first between twenty-five and thirty open-hearth furnaces were idle for lack of scrap, the flow of which fell to about forty per cent of normal requirements during July. Usually about half the charge of an open-hearth furnace is scrap.

Its present scarcity is attributed to a number of causes, some of which are as follows:

During the coal strike of April and May the absence of coal to produce pig iron resulted in a larger percentage of scrap being employed in furnace charges. This depleted the stock.

Very little battlefield scrap has been returned and it is doubtful if much will be. Furthermore, the marine field has not yet yielded much scrap due to the slow disposal of unserviceable vessels. Ultimately this may prove a substantial source.

Strikes in consuming and fabricating industries, from which a large part of the scrap normally comes, have cut the supply; in addition to which there has been labor shortage in the scrap yards.

Finally, many potential and actual purchasers of new equipment, unable to get early deliveries of replacements, have found it necessary to hold on to old equipment instead of sending to the scrap pile. This situation also applies to the automobile field where "graveyard" scrap is now unusually low.

Notwithstanding these factors, which present more or less of a vicious circle, there is probably much usable scrap lying dormant around many plants which, if moved to the scrap market, would greatly assist in relieving the present conditions.

It will be recalled how, in the early days of the war, a country-wide campaign brought to light huge quantities of much needed scrap to get our war machine going. Perhaps a "Scrap for Peace" campaign may now be needed, as the situation appears critical. Meanwhile, let's scan the possibilities of our own contributions.

Where Data May Be Confusing

When looking up published data on steam plants, one frequently encounters confusion as to steam pressures listed. Design pressure is that which the drum is designed to withstand safely and corresponds with the setting of the first safety valve. This is somewhat higher than the drum operating pressure. Then there is the operating pressure at the superheater outlet which is still lower, the amount depending upon the pressure drop through the superheater. This, together with the steam temperature at the superheater outlet, may be considered to represent the steam conditions of the steam generating unit. However, when considering the prime mover, it is the pressure and temperature at the turbine throttle that is important. Therefore, if such data are to mean anything, it should be stated specifically where the steam pressure is taken.

Also, some confusion may exist concerning the term "maximum continuous capacity" unless there is a definite understanding of what is implied. It is the maximum sustained capacity at which a steam generating unit may be operated for an indefinite period, without interruption from such causes as excessive fouling of heat-absorbing surfaces. Where guarantees are involved the period is usually understood to be 24 hours. If boilers are intended to be operated for protracted periods at maximum capacity they must be conservatively designed. Much depends on the period for which they are expected to be so operated and on the character of coal burned. Unless this information is given, the maximum continuous capacity may lack definite meaning for comparative purposes.

ODYSSEY OF AN ENGINEER

By H. G. MEISSNER
Combustion Engineering Company

An account of a flight made by the author in the early days of the war to supervise acceptance tests of the boilers of a new power plant serving the town of Anchorage, Alaska and an adjacent air field. The numerous handicaps imposed by local conditions are cited, despite which the guaranteed efficiency of the boiler plant was exceeded. This consists of three 120,000-lb per hr, spreader-stoker-fired units supplying steam to two 5000-kw turbine-generators, as well as steam for heating of barracks, hangars, laundry and other services.

WITH the advent of global warfare in 1939 the necessity for a chain of strategically placed air fields became apparent, and the importance of Alaska as the hub for such a chain is evident, especially as regards our far-flung Pacific interests. Plans were immediately made to build such facilities, and with the subsequent Japanese attack on Pearl Harbor, the urgency of this work was increased a hundred-fold.

When word was received on December 12, 1941, that assistance was required to supervise acceptance tests of the newly installed boiler and stokers at the Elmendorf Field, Fort Richardson plant, near Anchorage, no time was lost in making the necessary arrangements and two days later, just a week after the Pearl Harbor attack, the writer was enroute.

The trip started prosaically enough, by train, as the New York to Chicago leg of the flight was grounded by bad weather. From there on it was a race with the weather and darkness. The radio beams had been silenced because of fear of Japanese use by bombers, so

Map of Alaska with course of flight indicated

"contact" flying was the rule, and when they say contact flying in Alaska, it is almost literally true. Hedge hopping is a fine art with the Northern pilots, but several times they decided to let the weather clear, and we would start out only to turn back in a little while and wait for another sunrise. With emergency fields few and far between, and the transport planes as far as Fairbanks using wheels instead of skis, landings on snow-covered lakes, as practiced by the bush pilots when in trouble was impossible; there had to be a reasonable chance of reaching the objective, or the flight was postponed. Intermediate stops were made at Prince George, Juneau, the capital, and Whitehorse, names long familiar in song and story.

Coming into Fairbanks, a town of 3000 inhabitants, our Lockheed kept dropping down to stay under the overcast, and finally landed after brushing the snow off the tops of adjacent trees. The Douglas which had preceded us, elected to keep above the clouds, and was forced to circle over the field for almost an hour, before finding a hole big enough to set down in. Fairbanks seemed cold, about 30 below, but after talking with the natives who boasted of 50 and 60 below, we decided not to complain.

The final leg to Anchorage, which had a normal population of about 2500, was flown just 6 days after leaving New York, was made in a single engine Waco, piloted by Bill Lavery, one of the veterans of the local pilots. The wind over the "Hump" was of gale force, and we skimmed the snow-capped ridge by what looked like a couple of yards. The knowledge that he had been making this run for some fifteen years without mishap, was encouraging. Mt. McKinley reared its 20,000 ft some miles to the West, a majestic sight.

A warm reception was accorded at Anchorage from the construction company engineers, and within an hour of arrival we were in the midst of our program covering the work required to get ready for the acceptance tests. Preliminary tests had been under way for some time, but it was apparent that further adjustment of controls and instruction of the operators was essential, so the following week was devoted to this work.

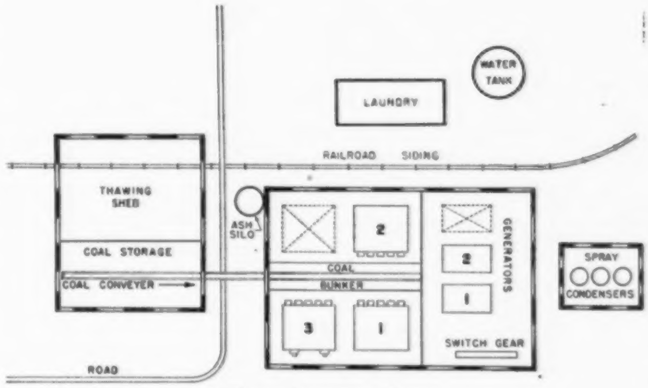
Everything Had To Be Brought In

Construction of the Anchorage power plant had been started in the spring of 1941. Practically everything used in the plant had to be brought in from the States, including the lumber used for the buildings, and most of the construction personnel also came from outside. All food except some fresh vegetables was also imported. The normal population of the territory was less than 80,000, about half of which consisted of Indians and Eskimos, and few of either were farmers. The Matanuska farm settlement near Anchorage, which started with several thousand persons, was badly depleted by those who had returned to the States because of the primitive living conditions and lack of markets. Arrangements were, therefore, made between the Army Quartermaster and the local Chamber of Commerce, covering the fresh food and meat supplies which would be purchased from the farmers.

As the ground remains perpetually frozen about two feet below the surface, with a gravel subsoil, the produce which can be grown is limited to that having shallow roots. The total annual hours of sunlight are said to equal those in our Northern States, but they are concentrated in the short summer months. In Fairbanks a baseball game is played annually at midnight on June 21, and no flood lights are required.

Anchorage is located at the head of Cook Inlet, which has a tidal rise and fall of some 30 ft, and which cuts part way into the Kenai Peninsula. The latter projects down into the Gulf of Alaska, as the accompanying map shows, and as the Japan current swings around to travel along the western coast of the United States, it serves to raise the average temperatures considerably above those encountered in the interior. It is the conflict between the warm Japan current and the cold Arctic ocean, where they meet at the Aleutian Islands, which causes the heavy fogs, and sudden storms, including the "williwaws" which are among the problems faced by the local flyers.

Across the neck of the Kenai Peninsula to the southeast lies Seward, directly on the Gulf of Alaska, and an



Plan of power plant

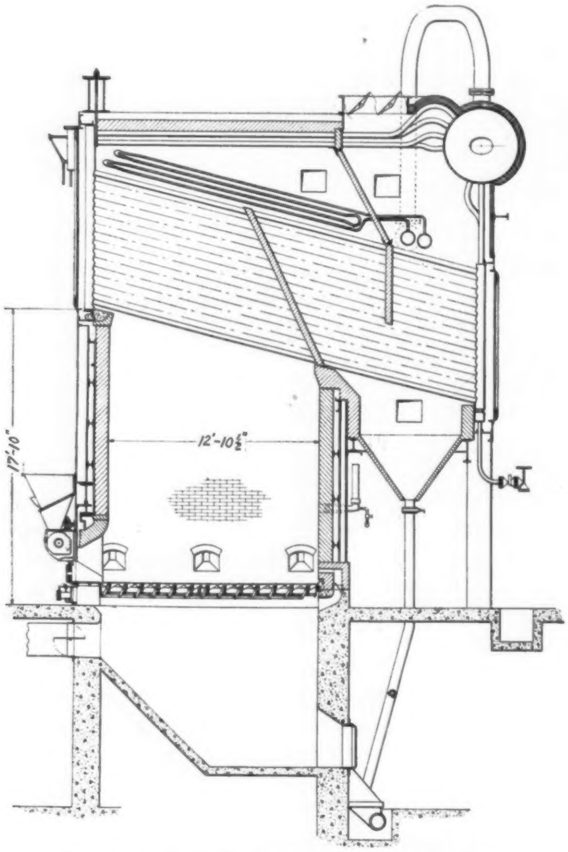
all-year port. As there was no through land route from the States, all material and supplies not flown in were shipped from Seattle to Seward, via the Inland Passage, which is icefree and relatively safe from submarine attack. From Seward the Alaska Railroad transported the shipments to Anchorage, an overnight trip, or on to Fairbanks an additional two days of winding mountain travel. By comparison the flying time from Anchorage to Fairbanks was two hours or less, so it is not surprising that Alaskans are air-minded.

Special crating and packing were required to assure safe delivery through these several transfers, and with the best of care, lost and broken shipments were not uncommon.

The power plant at Fort Richardson was built to supply power and heating steam for the hangars, laundry and some of the barracks at Elmendorf Field. At the time of the acceptance tests the hangars were under construction, and many of the other facilities were incomplete, so that there was only a fraction of the designed load in operation. It was necessary, therefore, to install a steam discharge pipe at the side of the building for excess boiler output, and to load the generator with a water rheostat. With the generator loaded to the desired output, the control valve in the waste steam line was adjusted to put the test load on the boiler. The noise of this steam discharge was very penetrating, and at the time no suitable muffler was available, so that full-load operation was limited to actual test periods, giving us little time for practice and adjustments.

The generating equipment consisted of two 5,000-kw Westinghouse units, one of which ran condensing, the other, or spare unit, being noncondensing.

The boiler equipment comprised three C-E sectional-header units, each rated at 120,000 lb of steam per hour at 210 psi at the superheater outlet and 500 F total steam temperature, with a feedwater temperature of 212 F. The boilers were fired by C-E spreader stokers, the grate surfaces being 25 ft wide by 13 ft long, with an effective area of 325 sq ft each. The coal distributors consisted of five units per stoker, with the standard motor and variable-speed drive. Space was provided for a fourth similar boiler, and in the generator room provision was made for a third unit.



Section through steam-generating unit

Boiler No. 3, in addition to the spreader stokers, was equipped with Peabody wide-range oil burners, set in the rear wall. For the oil-fired tests the stoker grate was covered with steel plates, asbestos board and refractory, and the spreader unit openings were bricked over.

As this part of Alaska is subject to rather severe earthquakes, all steelwork was strongly reinforced, especially such parts as the boiler supporting steel. As a heavy tremor had occurred when the boilers were partly erected, we checked the settings by transit and line and found them unaffected.

The extreme cold experienced in this part of Alaska introduced many special problems. When the boilers were first started in November, the building was not completed, and with the temperature well below zero, the water column lines froze, even with pressure on the steam gage. These lines had to be thawed out with torches, and insulated, so that the space heaters could be put in service to warm up the building.

All air entering the building was tempered by passing through fin-tube heaters, and those coils on the cold side had to be partially insulated, to prevent freezing, even with the steam turned on.

The cooling towers proved quite a problem, until the pitch of the fans was changed to reduce the air flow and the sprays were so adjusted that no moisture was deposited on the blades. The temperature variation between summer and winter ranged from plus 100 F to minus 50 F, so temperature control for equipment exposed to air flow required special attention in order to cope with such conditions.

Coal Available

All coal was brought in by rail from the mines which were located some fifty miles back in the mountains near the Matanuska Valley. It was run into the thawing shed for twenty-four hours and then unloaded. Before the thawing shed was completed, frozen coal had damaged the coal-handling and firing equipment rather severely. The storage bunkers were steam heated, and at the same time thermocouples were inserted into the coal pile and checked daily to avoid spontaneous combustion, as the local fuel was quite similar to mid-western coal in this respect. Typical analyses are given in the accompanying tabulation.

ALASKA COAL ANALYSIS

Coal	Vol.	Fixed C	Moisture	Ash	Sulphur	Btu per Lb	Ash-fusion Temp.
1. Evans Jones, ¾ in. × 0	35.5	40.1	9.9	14.5	0.3	10,680	....
2. Evans Jones, Jonesville Nut	39.7	43.1	6.6	10.6	0.3	11,725	....
3. Evans Jones, Jonesville Nut 15/16 in. × 0	36.5	43.7	8.9	10.9	0.3	11,375	....
4. Evans Jones, Jonesville Nut No 8	34.4	42.1	5.4	18.1	0.3	10,960	2910
5. Evans Jones, Jonesville Nut	36.4	42.8	8.8	12.0	0.3	11,195	...
6. Matanuska-Premier–Moose Creek	39.3	45.0	4.5	11.2	0.4	12,050	2620
7. Lower Matanuska–Eska–Upper Shaw	38.5	41.6	4.9	15.0	0.4	11,700	2910
8. Golden Zone Mine-W. E. Dunkle	42.3	39.6	13.6	4.5	0.3	11,165	....
9. Costello Creek-Colorado Sta., Subbituminous	37.3	39.7	16.2	6.8	0.2	10,100	....

Much lignite and subbituminous coal is available and there are extensive deposits of higher rank fuels, with some semi-anthracite. Oil is plentiful but largely untapped, and minerals, such as nickel chrome and copper are awaiting favorable market conditions for their production. Gold production, by both hard rock and placer mining, easily leads in the value of all mineral output of the region.

With the surprise attack at Pearl Harbor fresh in mind, unusual precautions against air attack were necessary, especially during the hours just before and shortly after sunrise, which at this, the shortest days of the year, were from about 6 to 10 a.m. Strict blackout regulations were enforced from sunset to sunrise, and as the hotel windows were not provided with effective blackout curtains, it was necessary to learn to dress in total darkness.

At the plant, all windows were blacked with paint, but because of the extreme cold, this was found to crack and fall off, so that aside from small blue bulbs over the control panels, light was limited to carefully used flashlights. This proved quite a handicap, as moving around in a plant of this size, and with four levels of gratings, was not to be done carelessly. It was always with sighs of relief that we heard the welcome instructions "lights on" about 10 a.m.

The general instructions covering air raids called for all operators to stay at their posts until given orders to go to the shelters. The shelter assigned to the boiler room force was located beneath the coal conveyor, which in turn was under the coal bunker, a good solid concrete structure which we kept filled with several thousand tons of coal.

Soot blowing schedules were adjusted to avoid daylight stack emission and operation with a minimum of smoke was always essential.

As the power plant was located adjacent to the air field, there was opportunity to observe the activities of the flyers in their practice and reconnaissance flights, during which they seemed to take delight in buzzing the power house and construction buildings. As we were never sure that the planes overhead were friendly there was always the chance that the power dive would be followed by the blast of a bomb, as our building would be sure to receive attention from any enemy bombers.

There were several alarms, when uncertainty existed as to the identity of planes sighted over the coast, and no time would be lost in running all available automotive equipment out on the field, leaving only a narrow runway for our interceptors to take off. Various barricades and other obstructions were kept in place to prevent landings by enemy aircraft. Such raids were most likely to be made just at dawn, from planes taking off from aircraft carriers which would approach the coast under cover of darkness, or fog, of which there was plenty in this part of Alaska.

Fortunately, there were no enemy aliens to trouble us, as the FBI had done a thorough job in rounding up all possible suspects within a few hours of the Pearl Harbor attack. In a thinly settled country such as this it would be almost impossible for an enemy agent to hide out, as without help from the natives, a stranger in town would soon attract attention. We were all amused when a new arrival tried to steal a car. With all roads ending within a few miles of town, it was only a matter of hours before he was reported and put in jail.

Acceptance Tests

The various coal-fired and generator acceptance tests were run during the latter part of December 1941 and January 1942, with all equipment meeting or exceeding the guaranteed performance. There being no plant noisemaker except the air raid siren, it was necessary to rig up a low water alarm to whistle in the New Year.

The oil-fired test was finally run in February, some difficulty being experienced in securing the required oil supply. This was so limited that little was available for tune-up adjustments or training of the operators on this fuel. However, the Chief Engineer agreed to take care of the latter obligation as fuel oil became available.

Training the operating crews proved to be one of the major problems encountered. The plant was started and the acceptance tests were run by members of the construction force, most of whom were not only good mechanics, but had worked on power plant projects previously, so that they had some knowledge of plant operation. The inducements which were offered to these men to stay at the plant as part of the permanent operating force proved insufficient, and when the construction work was completed they returned to the States. We were then faced with the necessity of recruiting and training an entire new crew from the available manpower in a territory thinly populated at best and further depleted by the draft and availability of more lucrative jobs elsewhere.

After much trial and error, a group of native Alaskans was brought together and trained, which, with the able and patient cooperation of the plant Chief Engineer, proved to be capable of maintaining the plant in reliable and efficient operation, as subsequent reports have shown. Some of these men had been prospectors, several had previous experience in handling the engines of local fishing vessels, a couple had worked in the coal mines, and others qualified because of their experience in placer or hard rock mining, where the ability to keep machinery going under the most adverse conditions was a necessity. So far as we could determine, none of them (with one or two possible exceptions) had any previous experience in operating a steam-generating plant. Perhaps this was an asset rather than a liability, because they had no "unlearning" to do. It was therefore with considerable satisfaction that a notation was found in a recent U.S.E.D. report, commenting on subsequent performance, as follows:

"U. S. Engineers consider the Anchorage Air Base Plant one of the best of their operations. Over a period of years, the efficiency of all three boilers has exceeded the guaranteed efficiency, by at least two points, and the maintenance costs have been extremely low. The plant is now supplying, not only the Air Base, but also the town of Anchorage, with electric power."

The return trip, via plane, in early March was a study in contrasts, from arctic winter in Alaska to summer heat in Los Angeles, and March winds in New York, all within a matter of days. Such a trip would be impossible without a wide flung network of air fields of which Anchorage is a new and important link.

Corrosion Research

The Navy Department's Office of Research and Invention has recently sponsored a fundamental corrosion research project to be conducted at Ohio State University, under the direction of Dr. M. G. Fontana, professor of metallurgical research at the University's Engineering Experiment Station.

Too often, explains Dr. Fontana, corrosion studies simply involve a testing program, or the exposing of metals to corrosive influences and then reporting the rate of attack; but in this investigation an attempt will be made to ascertain the "whys" and "wherefores" of corrosion.

Furthermore, the Navy has imposed no restrictions on details of the research methods to be employed, nor upon publication of the findings. Hence, it is anticipated that the results of this investigation will also be of benefit to the nation in general, for it has been estimated that the national corrosion bill amounts to as much as a billion dollars annually.

In addition to the Navy program the Experiment Station has received a special grant from the Research Corporation for the study of corrosion test methods and erosion-corrosion.

Industrial Use of Coal in Germany

●Information on German power plant practice has been scant for several years, not only because technical literature from that country did not reach American readers during the war, but also because of restrictions imposed during the immediate pre-war years. Therefore, the following excerpts from a talk by H. A. Herder, Fuel Engineer of the Sahara Coal Company, before the A.S.M.E. Meeting in Detroit will prove interesting. Mr. Herder was one of a party of American engineers sent to Germany following the war to investigate German fuel burning practice. His observations tie in very closely with those contained in the recently released government report of the War Utilities Sub-Committee, a brief review of which is here included to supplement Mr. Herder's observations.

THE industrial use of coal in Germany is predicated on the general economic condition of fuel that exists in that country. Germany has no petroleum and no natural gas, therefore coal is the primary source of fuel.

Coals mined in Germany are bituminous and brown coal, with a small amount of anthracite. The bituminous coal production in 1938 was approximately 185 million metric tons, and the principal producing areas are Aachen, Ruhr (including Krefeld), Silesia, Saxony and Saar. The brown coal production in 1938 was approximately 190 million metric tons, coming from some twelve districts, the principal areas being Cologne, Kassel and Silesia.

Bituminous Coal Mining

Bituminous mines, producing coal very similar to American coals ranging in volatile content from 12 to 38 per cent, are deep shaft mines extending as much as 2200 ft below the surface. The seams are generally thin, about 3 ft, and pitching. In many mines two or more seams are mined from the same shaft. The coal is mostly hand-loaded, but in the last few years a mechanical coal planer has been used. Due to these natural conditions, the coal mined per day per man was low.

The surface construction of a bituminous mine in Germany makes the actual mining of coal seem secondary. The cleaning plants are several times as large as those in the United States for the same tonnage, but when their coal is cleaned, the separation of coal and extraneous material is complete. Surface construction also includes coke ovens, nitrogen plants, and electric generating plants. A tremendous area is covered with surface structures around a coal mine.

The bituminous coal is used primarily in coke ovens and for metallurgical and other engineering uses.

Brown Coal Production

The brown coal is produced from open pit mines, and is a grade below our lignite. It lies in beds up to 250 ft thick and only 50 to 75 ft below the surface, and contains 40 to 60 per cent moisture. The color is definitely brown, resembling rotted tree stumps. This coal is very susceptible to spontaneous combustion and must be either used or processed as it is produced. Electric generating plants consume about one-third of the total production at the mine sites. The balance is processed into briquettes and is used primarily for household heating. The freshly mined brown coal is put through dryers and the briquettes are formed by impact without a binder. They come from the briquetting plant unit onto a conveyor to drying and cooling racks. This method has been used since the late eighteen hundreds.

The area covered by this investigation was all in the American, British and French zones of occupation, plants being visited in Hanover, Kassel, the Ruhr District, Cologne, Wiesbaden, Frankfort, Heidelberg, Mannheim, Stuttgart, Munich, Nuremberg and the Saar Basin.

The coal-burning equipment observed in German plants could be divided into three types and discussed as such, namely, pulverized fuel, chain grates and inclined grates. Only one of the plants visited had an underfeed stoker.

Pulverized Fuel

Pulverized fuel equipment was used quite generally in the electric generating stations, burning either bituminous or brown coal. These pulverizers were mostly hammer-type mills, usually with fixed hammers instead of the swinging type. From observation of the flames, it did not seem that pulverization was as fine as is the general practice in the United States. Most of the boiler units had a capacity of 150,000 to 250,000 lb of steam per hour. These employed either four or eight mills and burners per unit, depending on the type of coal used. The furnaces were all water-walled with dry bottoms. Where brown coal was used the mills had large openings in the top to allow the wet coal to drop down onto the revolving hammer plates, and large openings in a horizontal direction off the center to feed the pulverized coal into the furnace. The openings for the finished product to enter the furnace were almost the full width of the mill and about $2^1/_2$ ft in elevation. Apparently the brown coal made one revolution through the mill and was then blown into the furnace in a very coarse condition. In some of these cases the furnace bottom was inclined toward the center on about a 45-deg angle until the opening was about 4 ft square. Across this opening would be a set of water

tube grates to burn the larger particles that did not burn in suspension.

The bituminous coal burned in these generating plants was a type not generally burned in this country. It is reject from the cleaning plants, ranging in ash content as high as 40 per cent with a top size of about $^1/_4$ in., and often dripping wet. The power plants being located at mine sites eliminate any transportation charge on fuel, and make it economical to build plants to use such poor quality fuel.

Mine-Mouth Power Plants Feed Transmission Networks

Germany is crossed in many directions with power lines extending from the coal-producing areas in the north down to the mountainous area in the south. In the south and along the rivers hydroelectric power is produced wherever there is enough water to turn the turbines. In the mining area, power is produced at almost every mining operation. This power is fed into the cross-country transmission lines for general consumption. Apparently they are able to produce power from the poor quality refuse coal and absorb the line loss and still make it attractive for many industries to purchase power rather than operate their own generating units in local communities burning shipped-in coal.

Two modern pulverized-coal-burning plants were visited which could be described as the most advanced seen in Germany. One was a large electric generating plant at Essen in the Ruhr area, and the other was a chemical plant isolated in the hills of Southeastern Germany near Austria. The boilers of the latter were of the Benson forced-circulation type, of which there are said to be about 80 installed in that country. They were each provided with three pulverizers and eight burners per boiler. These steam-generating units are of the once-through design without drums. The furnace sides and bottoms were of hollow tile construction and used for preheating air for coal drying at the pulverizers and feeders. The exit gas temperature is about 430 F when the unit is producing steam with a final temperature of 950 F and 1500 psi pressure. The reported heat release for such a unit was approximately 15,000 Btu per cu ft of furnace volume per hour. The forced circulation pumps and the coal feed to the burners are controlled automatically by the steam demand.

Efficiency was reported between 85 and 87 per cent for these units. They were operated at a fixed load and any power generated in excess of plant requirements was fed into the transmission lines.

High Steam Pressures Predominant

The boiler pressure usually encountered in the larger plants visited ranged from 1200 to 1800 psi. The highest pressure plant found was in Southern Germany. This operated at 2200 psi, 875 F and burned both schlem coal, of 14 to 21 per cent moisture, 21 to 27 per cent ash, and Saar coal, of 7 to 8 per cent moisture and 7 to 8 per cent ash. During the war this plant was allowed only 20 per cent coal and 80 per cent schlem, which mixture they learned to burn satisfactorily. The latest boilers in this plant had a capacity of 200,000 lb per hr and were installed in 1940. They were fired with pulverized coal at the lower four corners, and when blast furnace gas was available it was used in conjunction with coal. They had water walls and dry-ash type of furnace bottoms.

Chain Grate Stokers

Chain grate stokers were found in most of the moderate size industrial plants, and most of them were designed to burn a wide range of coal quality.

One interesting plant was located at a coal mine in the Saar. The boilers were of the three-drum type designed to produce 55,000 lb of steam per hour at 200 psi and 650 F final steam temperature. The sides of the furnace were water walled and each boiler was equipped with two chain grate stokers. Running from front to back through the center of the furnace was a vertical wall separating the operation of the two stokers. This was a refractory wall and no maintenance difficulties were reported. This is no doubt the result of low heat release in the furnace, as the maximum coal-burning rate was only 28 lb per sq ft of grate per hour. This was forced draft unit with six air zones, and carried a fuel bed thickness of 7 to 8 in. The coal contained 30 per cent ash and 15 per cent moisture. This coal had been subjected to one phase of cleaning which accounted for the high ash—but instead of further preparation to get the balance of the coal they elected to burn this fraction of their production.

The links on the chain grate stokers were set at right angles to the grate travel. These links were 16 in. long, $^3/_4$ in. wide and 4 in. thick. They were designed with 22 small air veins on the face of the link which sloped about 60 deg toward the hopper end of the stoker. This, of course, was to direct the forced draft air to the front of the fuel bed.

Inclined Grates

Inclined grate stokers were used primarily at mine site locations, burning brown coal or the sludge or slurry from the bituminous coal mine cleaning plants. The units burning brown coal were all quite similar, progressing from manual operation to full automatic control. The manually operated grates consisted of flat steel plates set horizontally across the furnace and stepped inward so the grate area was on a 20-deg incline. The more modern forced-draft stokers had well-designed reciprocating grates. The brown coal being free burning presented no problem when burned on this type of equipment.

One very interesting inclined grate design was observed in the Ruhr area burning the slurry from a bituminous mine washing plant. The entire bin arrangement, conveyors, bunkers and stokers were specifically designed for the 35 per cent ash, 12 to 35 per cent moisture coal with a top size of 2 mm and averaging less than 5000 Btu per pound as fired. The coal is taken from ground level drainage pits to an overhead bunker. From this bunker it is conveyed horizontally to the stoker hopper. The stoker hopper extends across the full width of the furnace front and up to the conveyor from the bunker. It is a rectangular vertical chute which makes a 90-deg arc at the grate level so as to move the coal into the furnace horizontally. At the position of the arc there is an inside reciprocating shoe feeder operated on a piston-actuated jack shaft, the speed of which is controlled by steam demand.

A column of coal 20 in. high and extending across the furnace moves horizontally onto a drying and coking plate inside the furnace. At intervals a column of dried and partially coked fuel 6 to 8 in. thick is forced off the coking plate onto inclined receiprocating grates set at an angle of 20 deg to the horizontal. The grate plates are 14 in. long and 2 in. wide, and so designed and operated that the reciprocating motion moves the bottom of the fuel bed toward the coking plate, the top of the fuel bed toward the ash discharge, and the fresh charge of coke filters through the fuel bed and then is brought to the feed end and down on top as it is burned out. This action breaks up the larger pieces of coke on the grates and gives a uniform fuel bed thickness, in turn making for better forced draft air distribution and resulting in good overall efficiency. The undergrate air chamber is divided into four zones.

The throw of the grates is adjustable, and their operation is controlled by steam pressure. This installation has 30 sets of grates from front wall to back. This is a maximum overlap on the grates of about 6 inches. The ash is discharged over a sprocketed cylinder having a controlled clockwise motion to maintain ash coverage for the rear grates. The stoker was installed under a boiler with a capacity of 77,000 lb of steam per hour and operated at 510 psi with a reported efficiency of 86 per cent.

Most of the electric generating plants visited were in operation—some only partially—but all had some units under load. The industrial plants were all badly damaged and only one or two were in physical condition to operate.

Supplementing Mr. Herder's paper, a review of the Utilities Sub-Committee Report, and certain other sources, reveals that relatively few steam-electric utility plants in Germany were severely damaged, bombing having apparently been concentrated on the important industrial power plants, particularly those serving the chemical industry.

In general, large industrial power plants in Germany seemed to go in for higher steam pressures and temperatures than, with some exceptions, is common for such installations in the United States. Pressures of 1200 to 1800 psi predominated, with 2200 psi as a maximum, and steam temperatures ranged from 930 to 950 F. Both topping and condensing turbines were employed and the strategic locations of many of these plants were not favored with large condensing water supply, hence cooling towers were common.

While certain of these plants had large total steam generating capacity, in one case up to nearly 5 million pounds of steam per hour, in only one case noted were the individual steam generating units as large as 395,000 lb per hr. The more usual capacity of high-pressure units ranged from 100,000 to 220,000 lb per hr rated output. Where large total steam requirements were involved, a multiplicity of boilers was found.

Before the steel situation became critical about 80 per cent of the industrial boilers employed natural circulation, but just prior to and during the war about half the new boilers installed were of the forced-circulation type mostly without drums, thus saving up to 10 per cent of the steel.

Many of these high-pressure units were of special types, such as the once-through, forced-circulation Benson and Sulzer designs without drums, which predominated; La Mont controlled forced-circulation type with drum; the Loeffler design in which steam is pumped to an evaporating drum; the Steinmuller boiler; the Durr-Wolf natural-circulation design; and the Schmidt-Hartmann double-evaporation type. The last mentioned, it may be recalled, is a natural-circulation boiler in which high-pressure saturated steam is produced in the primary circuit and passed from a steam-collecting drum to an upper heat-exchange drum where it is condensed in the tubes and returned to the saturated steam drum. The heat given up evaporates water in the heat-exchange drum and this steam passes to the superheater. Only one to two gallons of makeup per week are said to be required by the primary circuit. Such a unit is claimed to be advantageous where process makeup or steam heating requirements are such as to be too high for economical use of evaporators.

Some of these special type boilers were fired by Kramer mills and others employed conventional pulverizers. The once-through units without drums were reported as difficult to regulate under variable load, hence they were usually operated on steady load with other boilers in the plant taking the swings.

Among the later high-pressure steam generating units were also a number of the KSG natural-circulation design in capacities up to 220,000 lb per hr, having completely water-cooled furnaces tangentially fired with pulverized coal. Dry-bottom furnaces, economizers and air preheaters were general with most types of units and electrostatic fly-ash collectors were found in many plants.

In a number of installations process steam was obtained through the use of so-called "steam transformers," the condensate from which was employed for boiler feed.

It was common practice to operate the high-pressure boilers with about 5000 ppm in the boiler water. Also, in contrast with practice in the United States, and despite the extensive use of dry drums, there appeared to be an absence of effective methods of steam separation. This was reflected in a generally accepted steam contamination of 2 to 4 ppm, and resulted in numerous cases of troublesome turbine blade deposits.

The foregoing applies to industrial power plant practice in the American, British and French occupied sections. In the central station field some of the later extensions included high-pressure units of the types mentioned, and turbines up to 50,000 kw capacity, but for the greater part capacity was made up of older units. A number were located at the mines. The largest single station noted was Goldenberg, near Cologne, with a rated capacity of 550,000 kw, but the steam pressure was low and it contained 98 boilers and 22 turbine-generators of various capacities.

Berlin is served by a system fed by nine stations having a combined capacity of 740,000 kw. None of these are new and they have long since been described.

One modern station, Karnat, near Essen, which was completed in 1944, contains ten 296,000-lb per hr pulverized-coal fired Benson boilers supplying steam at 1470 psi, 950 F to five 50,000 kw turbine-generators. Boiler efficiencies up to 87 per cent were reported at three-quarters load and 85.5 per cent at full load.

"Hot? You think this is hot?"

"You should've been on the boiler room job we just finished. We were covering lines that had 450° steam in 'em. Man, was it sizzling!"

"When you've worked for Armstrong as long as I have, son, you'll run into plenty of heat insulation jobs hotter than that one."

"I just hope keeping the steam up saves the customer as much money as they say it does, because it's doggoned hot work."

"Wait 'til you get on a really hot one! I worked on a job years ago . . ."

"Now, don't tell me it was any hotter than 450°."

"Sure was, and they had to get this plant running quick. So we put the high-temp block on the breechings after they fired up. And the gas in breechings used to run up to 700°!"

"About that time I'd have been begging to get on one of Armstrong's nice cool jobs—like putting cork covering in an ice cream plant."

"What, and get smeared with that sticky black cement! But ice cream is a good idea. Let's get some. It *is* kinda warm today, at that."

This story is fiction—but it is fiction based on what might have happened in any of the twenty-seven districts throughout the country where Armstrong men work. Our men don't enjoy working under difficult conditions, but they do take a good workman's pride in handling a tough assignment.

Almost every job has its own special problems, even though it's only cramped working quarters or moving machinery to keep clear of. The answers to all the problems encountered on heat insulation jobs aren't found in books. They have to be figured out on the spot by men with lots of experience. You'll find such experience in the mechanics, foremen, and superintendents who install both heat insulation and low-temperature insulation for the Armstrong Cork Company.

If you'd like to know more about these men and the type of work they can do for you, let us send you the free booklet, "Armstrong's Contract Service." We think you'll find it interesting. Just write to Armstrong Cork Co., Building Materials Div., 9308 Maple Avenue, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATION

Complete Contract Service
For All Temperatures

From 300° Below Zero

To 2600° Fahrenheit

Proposed Atomic Power System

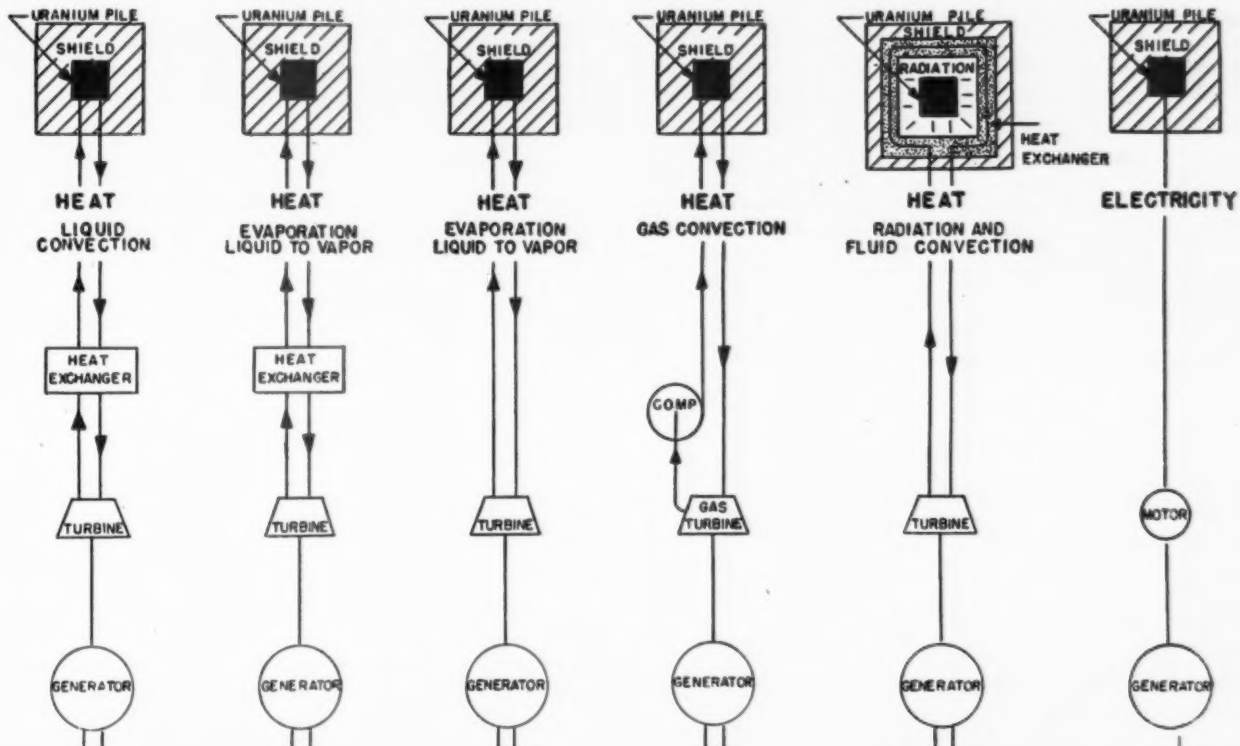
In an address before the recent Annual Meeting of the Edison Electric Institute, H. A. Winne, vice president of the General Electric Company outlined certain engineering aspects of atomic energy as applied to power generation and sketched several schemes that have been proposed. Following are some excerpts from his paper.

THE energy released by fission of uranium 235 or plutonium appears almost instantly as sensible heat energy in the active material and the engineer's problem is to devise heat or thermodynamic systems to transform this heat into mechanical or electrical power. One may expect the use of well-known devices, such as heat-exchangers, turbines and heat-transfer fluids for conveying heat from one mechanism to another. However, conditions associated with nuclear reaction introduce new factors which place certain definite limitations on the system and its components.

An important requirement affecting the choice of heat system is the necessity of shielding power plant personnel and equipment from all neutron and gamma-ray radiation. Such shields may be 5 ft or more in thickness, including a considerable amount of heavy material, such as iron or lead. The heat-transfer fluid passing through the "pile" will become more or less radioactive. Therefore all pipes, pumps and equipment carrying the primary heat-transfer fluid will require shielding for gamma radiation. If intermediate heat-exchangers are to transfer heat to a secondary fluid, it may be possible to eliminate shielding on the secondary system.

Fig. 1[1] represents diagrammatically six systems illustrating some of the large number of variations which one can conceive. All except the last use a heat-transfer fluid to transform heat into mechanical power at the blades of a turbine.

System *A* uses a liquid to transfer the heat from the "pile" or nuclear reactor to a heat-exchanger in a closed cycle. The heat-exchanger might then generate steam for use in a standard turbine-generator. This system would not require gamma radiation shielding beyond the heat-exchanger.



Schematic diagrams of suggested systems

System *B* is like System *A*, except that the liquid is evaporated in the pile and the vapor condensed in the heat-exchanger before return to the pile. This permits circulating less liquid as the latent heat from evaporation

[1] Reproduced from the Edison Electric Institute Bulletin.

is utilized. The boiling may introduce problems in the control of the neutron flux. However, it may be possible to find a fluid in which the effect on neutron density is approximately the same for vapor as for liquid, in which case the system has some advantages.

System *C* shows evaporation of the liquid to a vapor which is used directly in the turbine instead of in an intermediate heat-exchanger. This might permit a higher temperature in the turbine and higher efficiency, but would require that the turbine be shielded.

System *D* contemplates the use of a gas which transfers heat directly from the pile to a gas turbine. A closed cycle is shown, which requires a large compressor developing perhaps twice as much power as the useful power taken from the shaft of the turbine. Suitable gases with low neutron absorption exist, but to produce appreciable amounts of power the low thermal capacity of the gas will require either extremely large flow, high temperature or high pressure. If machine sizes are to be kept small all three factors should be increased within the limitations of existing material.

System *E* has been suggested as a means of using atomic energy in a nearly standard steam boiler and turbine equipment. The pile would be placed inside the boiler and transfer heat to it by radiation. Such a system has several disadvantages. To achieve reasonable size the pile would have to operate at extremely high temperature, perhaps that of incandescence. The problem of materials, construction and instrumentation of an incandescent pile are obviously formidable. The water in the boiler, turbine, condenser, feed system, etc., would be radioactive and require shielding of the entire system.

System *F* is included to indicate the possibility of new inventions. This system represents the changing of heat energy directly into electrical energy. No practical solution of this type exists at present.

In comparing the efficiencies of these cycles with the conventional steam power plant, it will be noted that stack losses, as such, do not exist, but heat is still rejected in a condenser, in the vapor cycle.

Engineering Problems

The power density in a chain-recting pile can obviously vary from the low density used at Hanford to the tremendous density of the atomic bomb. Therefore, power density is determined not by the rate at which energy can be generated but by the rate at which it can be taken away by heat transfer. A considerable amount of development work is needed on many phases of heat transfer, such as (1) development of suitable fluids including metal alloys and gases (transmutations within the heat-transfer fluid may change its properties during operation); (2) materials permitting the use of high temperatures and high fluid velocity, for appreciable erosion cannot be permitted as replacement of parts within a pile would be extremely difficult; (3) corrosion, scale and contamination of fluids; and (4) physical arrangement of heat-transfer surfaces in order to conserve critical and expensive materials.

Economics

Some of the factors which are rather apt to be overlooked, but which must be taken into account in any attempt to study the economics of atomic fuels are as follows:

While it is possible to establish a chain reaction using natural uranium with its 0.7 per cent U-235, as at Hanford, these piles are very large. However, because of size, it is likely that fuels enriched with additional U-235 or Pu-239 would be used for piles to develop power. The cost of producing such enriched fuels is certain to be considerable. Materials used in atomic bombs represent the extreme example of enriched fuel.

As disclosed in the report of The Secretary of State's Committee on Atomic Energy, it may be in the interest of world security to denature fuels supplied for industrial or other uses, but such a process may contribute appreciably to the cost of the fuel.

Inasmuch as the total world resources of uranium and thorium may be distinctly limited it will probably be necessary to conserve them by reclaiming U-238 and other critical materials from the ash. The cost would be chargeable to the continued use of atomic fuel for power.

The considerable magnitude of investment for the initial charge, combined with the cost of refueling, handling and reclaiming critical materials is a limitation which may greatly affect the application of nuclear power.

It is impossible to make accurate analysis of the economics of atomic fuel on the basis of information generally available at present. The energy released by a pound of fissionable material, if completely consumed, is about equivalent to that from the combustion of 1500 tons of coal. On this basis, with efficiency of use, fixed charges and other items are assumed to be equal for both fuels, the total fuel cost for coal at $4 per ton is about the same as for fissionable material at $6000 per lb.

Applications

One should expect nuclear energy power plants to be applied first where some distinct benefit results from the extremely long life of the fuel and its extremely small volume.

In naval and merchant ships the range of atomic-powered ships on one fuel charge might be of the order of a million miles, and the small volume of the atomic fuel would make it possible to obtain this range without use of even the normal space for shipboard fuel storage. In naval operations this would eliminate the need for a supply train of tankers with their convoying ships. Also, since the weight and volume of the fuel is not critical, it may be economical to increase the power and speed of any class of vessels.

For mining and other activities in remote parts of the world, where it is difficult to transport fuel or transmit electric energy, atomic power plants may provide means for economically exploiting these resources. Also, it might find use in emergency power plants.

For railroads and aircraft, the shielding limitations, and to a lesser extent the investment and maintenance limitations, put them further away from possible application than any of the other fields.

The use of atomic power for public utilities will depend primarily on economic and national policy factors. All that can be said now is the active development of atomic power seems warranted for some of the preceding applications. Experience in these fields, surveys of the economic resources and establishment of security and conservation policies will give the answer in the future. We are at the very beginning of a long and expensive road of research, development, engineering and construction.

Law Decisions Involving Engineers' Payments

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HIGHER courts have of late rendered a number of important decisions relative to the collection of commissions and salaries by engineers. Also, such court citations may be advantageously used to win unavoidable suits, for which reason, their clipping for future reference is warranted.

Home Work

Under all circumstances an engineer who expects payment for work on Sundays and evenings at home must positively prove that his employer agreed to pay for extra services; otherwise he cannot recover a favorable verdict.

For example, in *Perlman v. Skolnick Building Corporation*, 39 Atl. (2d) 186, reported January 1945, the testimony showed facts, as follows: An engineer was employed for an indeterminate period at an agreed wage of \$100 a week for two weeks and \$125 a week thereafter on a forty-eight hour weekly basis with time and one-half for overtime. He worked for seven months when he was discharged, and was given a check for his last week's pay. The next day he returned the check with a demand for \$1738 for overtime on Sundays and holidays, and evening overtime work.

The engineer proved that he actually had worked overtime on Sundays and evenings, but he failed to prove that his employer agreed to pay extra for these additional services. Therefore, although the lower court held in favor of the engineer the higher court reversed the verdict, saying:

"It may have been convenient and perhaps profitable for this engineer to now and then finish his day's work or prepare for the morrow on Sundays . . .but assuming that the plaintiff did work Sundays and evenings at home he cannot recover pay for that service in addition to his regular wages. He not only does not show that any responsible officer of the corporation (employer) knew that he was working at home and agreed to pay him for it as overtime, but his conduct leaves no doubt that he understood any such work would be covered by his regular wages and for it he expected no extra compensation."

Recovery Allowed

Sometimes, engineers perform services with payments dependent upon successful termination of a lawsuit by the employer. According to a late higher court decision engineers are entitled to receive full payment for services rendered when the employer is awarded a court judgment although the employment contract may provide payment *if* the employer recovers "damages."

For example, in *Rowe v. Holmes*, 146 Pac. (2d) 45, reported January 1945, it was shown that a corporation employed an engineer in a suit to condemn lands, at \$75 per day to be paid "when we shall have recovered . . . the money or damages for our land." The corporation recovered a court judgment in such condemnation suit for about \$475,000.

The higher court held the corporation bound to pay the engineer before it actually received payment of the judgment. This court said that the words "recovery of damages" in a contract means a recovery of judgment.

City Contract

Considerable discussion has arisen from time to time over the legal question: May an engineer recover payment from a city for services rendered a municipality on an abandoned project? The answer is yes, if the city stood a chance to be benefited by services rendered by the engineer.

For illustration, in *De Leuw, Cather & Company v. City of Joliet*, 64 N.E. (2d) 779, reported May 1946, an engineer sued the city to recover for engineering services rendered in connection with a proposed new municipal waterworks system, to be financed by a Federal PWA loan of \$1,790,000. The engineer alleged that the value of the services rendered was \$46,350 although the city did not proceed with the work.

During the trial the testimony showed that in 1933, and for some years previous, the city was obtaining its water supply from deep wells, approximately 1600 to 1800 ft deep. There were also some driven wells with shallow water supply, connected with the system. The city maintained nine pumping stations 24 hr a day with three shifts of 27 men. The cost of pumping water in 1933 was \$46,138.66, and in 1934, \$49,137.70. Six of the stations were equipped with air-lift pumps, and the other three with deep-well turbines. Owing to a drop in the level of the water table, the supply was constantly shrinking in volume, and cost of pumping was correspondingly increased.

Because of these conditions, a motion was made and carried at a meeting of the city council instructing the city attorney to apply to the Federal RFC for a loan for the purpose of constructing a trunk line sewer on the west side of the city, a new water supply and system, and sewage treatment. The city attorney had conferences with engineering firms pertaining to the work that might be necessary to accomplish the purpose of the motion. Later an engineer was hired to do the preliminary engineering work. As above mentioned the project was not completed and the engineer sued for value of his services.

Notwithstanding the fact that the city failed to complete the project the higher court held the city liable for full value of the services rendered by the engineer. This court said that the services rendered by the engineer were worth even more than \$46,350, although the city was not benefited in the least.

In absence of restriction by state laws, a city possesses inherent power to employ an engineer in construction of public works.

For illustration, in *Moore v. City of Kokomo*, 60 N.E. (2d) 530, reported July 1945, it was shown that a city had a regular engineer. A state law gives the Board of Works and Safety power to condemn, rent or purchase property needed for public use. This Board and also the city council employed an engineer named Moore to perform services for the municipality. The latter refused to pay for the services rendered on the grounds that no city ordinance authorized the city council to make a valid contract to employ Moore. The lower court held that the City need not pay Moore. The higher court reviewed this verdict and said:

"In the absence of statutory restrictions a city possesses the inherent power to employ assistance in its legal department. We see no distinction for present purposes between legal assistance and engineering assistance."

Contract Assignable

Considerable discussion has arisen from time to time over the legal question: When is a contract for engineering services assignable? The answer is only when the contract does not specifically require the engineer to perform his personal services.

For instance, in *Commissioner of Internal Revenue v. Montgomery*, 144 Fed. (2d) 313, reported January 1945, it was shown that an engineer agreed to provide all materials and perform all work for construction of a public works as shown by the drawings and specifications, and under direction of an architect.

Later the engineer assigned the contract to a corporation which was formed by the engineer for the purpose of completing the contract.

In subsequent litigation the higher court held that the assignment was valid, saying:

"We agree that the contract was assignable. It did not employ Montgomery as an engineer, or require any personal service of him. It was a business contract to furnish labor and material and deliver a finished building."

Also, see *Lance v. Clark*, 41 Atl. (2d) 544, reported May 1945. The testimony proved that two consulting engineers agreed to render professional services in the preparation and proof of a claim for damages filed by their employer.

In the subsequent litigation the higher court held that the employer must pay the agreed contract price although only one of the engineers performed the agreed services.

Fault of Employer

Modern higher courts consistently hold that an engineer always is entitled to recover full payment of commissions if the employer is at fault. For example, in a leading case (104 N.Y.S. 362) the court explained that when an employee in good faith attempts to complete a contract he should not sustain any resulting loss caused by fault of his employer.

When an engineer acts as salesman, he can collect commissions from his employer strictly by the employment contract.

In a leading case (127 N.Y.S. 469) it was shown that the employer refused to pay the agreed commission. The engineer instituted legal proceedings but the court held him not entitled to compensation, because the buyer refused to accept and pay for the merchandise. The court said that an employer is not liable for the payment of a salesman's commission, under such circumstances, unless the employer had agreed to pay commissions on "all orders accepted."

On the other hand, under no circumstances will a higher court permit an employer to refuse payment of commissions where the contract of employment was designed to mislead the engineer.

In (82 N.W. 413), a contract existed between a manufacturer and his sales engineer which provided that "no commissions were to be paid" to the salesman on orders *not filled* or on goods returned by the purchaser or taken back by the employer for any fault whatever.

The employer without any good reason refused to ship merchandise specified in an order sent in by the salesman. It is interesting to observe that the court in this case held the employer liable for payment of the salesman's commission, irrespective of the written provisions in this contract.

This court held that where a salesman earns a commission he is entitled to it unless through his own fault the employer fails to deliver the goods or collect payment for them.

Conceals Facts

It is well-established law that an engineer is personally liable who fails to inform his employer of important facts pertaining to the latter's business.

For example, in *Anderson*, 20 S.E. (2d) 818, it was disclosed that an employer and his sales agent entered into a written contract by the terms of which the latter agreed to sell certain materials. The agent was to receive an agreed percentage of the sales price.

The evidence showed that without knowledge of his employer the agent *himself* became the actual purchaser and when paying the employer retained upon the transaction the sales commissions fixed by the employment contract, and also retained the profits upon the transactions when he resold the materials. The agent did not make a full disclosure to the employer that he was the actual purchaser. In other words, the agent accepted delivery of the materials from the employer, resold it at a profit, not disclosed to the employer, and remitted to the employer the price agreed upon in the contract, less the agent's commissions specified in the contract.

Upon discovery of these facts, the employer brought suit to recover the secret profits realized by the agent, *plus* the commissions paid to the agent under the contract of employment.

In holding the employer entitled to a recovery, the court said.

"Speaking generally, when an agent, in a fiduciary relation, is guilty of disloyalty to his principal and when by virtue of his position he seeks to make profit to himself rather than promote the interest of his principal, he is not entitled to compensation."

Also, see *Kinzbach Tool Company v. Corbett-Wallace Corporation*, 160 S.W. (2d) 509, where it was disclosed that an engineer, named Corbett, was the owner of sales right contract on a patented tool. Corbett decided that he would make an attempt to sell the contract right to a corporation. He made a deal with a salesman of the corporation to the effect that if this employee would assist him to sell the sales right he would pay the salesman $5000. The corporation's salesman approached an official of the corporation and, without informing this official

of his secret agreement with Corbett, the salesman finally induced the corporation officials to buy the sales right on the tool from Corbett for the sum of $25,000.

In subsequent litigation the higher court held that instead of paying Corbett $25,000 for the contract right, the corporation could deduct $5000 which Corbett agreed to pay to the salesman. Thus the corporation got the contract right for $20,000 and the salesman received nothing.

Sureties Liable

Modern higher courts consistently hold that sureties on public works are responsible for deficiencies in any and all legal payments due for engineering services. And, according to a late higher court decision, the sureties may recover their losses from the municipality, district or department obligated, originally, to make payment.

In *State ex rel. Lester v. Baker*, 160 Pac. (2d) 264, reported September 1945, it was shown that engineering and legal services were wrongfully paid out of a special improvement fund instead of a general fund. Suit was filed by the county. The higher court held that the sureties were liable for proper and legal payment and that the judgment should provide that the sureties should have judgment against the department of the state which were under legal obligations to pay for the engineering and legal services.

Overdrawn

In *Shepherd v. Richmond Engineering Company, Inc.*, 36 S.E. (2d) 531, reported March 1946, it was shown that an employer promised by written contract to pay an employee a specified percentage of the profits earned by the business. The employer advanced the employee considerably more money than his agreed one-half of the profits. The higher court refused to hold the employee must pay back to the employer the overdrawn money.

Conversely, the courts assume that an employer will pay a reasonable sum for services rendered by an employee, or other person, although there is nothing said about compensation. If, for example, an engineer and an employer enter into an agreement whereby the former becomes to perform services for the employer, it is not important if the contract does not specify the compensation payable. This is so because the court will listen to testimony by expert witnesses and thereby determine what amount would have been inserted in the contract, under ordinary circumstances. This is the amount that the engineer will recover for the services rendered. Obviously, it may be difficult for the court to render an absolutely fair verdict, because it must decide the amount reasonably due for exactly the same services, if rendered by another engineer having equal efficiency and experience, and under the identical circumstances.

Now, another subject of considerable importance relates to the method and time of payment. If a contract fails to include details in this respect, the court will assume that payment for services will be made in legal tender, and immediately on completion of the rendered services. Of course, past custom may have some influence on the verdict given by the court. If, for instance, previously the engineer rendered the same kind of services under an agreement whereby he was paid on a monthly basis, the court may compel the employer to make similar payments and on a monthly basis.

Gasification of Lignite and Subbituminous Coal

In a report to Secretary of the Interior J. A. Krug, Dr. R. R. Sayers, Director of the Bureau of Mines has stated that as part of a cooperative research program designed to utilize North Dakota lignite in the beneficiation of low-grade iron ores of Minnesota, the Bureau has demonstrated that both lignite and subbituminous coal yield reducing gases suitable for beneficiating iron ores as well as for the commercial production of industrial hydrogen or for the manufacture of synthetic liquid fuels and a host of other chemicals.

Although these lower-rank fuels have been considered inferior for most industrial purposes, lignite and subbituminous coal possess certain advantageous physical and chemical properties for gasification purposes that higher-rank fuels do not have.

Control of furnace temperature and rate of steaming proved to be important factors in the production of good quality water gas from lignite and subbituminous coal, according to a summarized progress report covering work accomplished in the carbonization and gasification of these fuels during 1944.

The carbonization and gasification of these fuels which represent further progress in the analysis and utilization of American coals have been conducted by the Bureau of Mines under a cooperative agreement with the University of North Dakota at Grand Forks, N.D., and the Colorado School of Mines, at Golden, Colo., with considerable additional laboratory and test work in the Bureau's Central Experiment Station at Pittsburgh, Pa.

Because no commercial equipment was available for experimental work on lignite gasification when the cooperative program was initiated late in 1943, a small pilot plant was constructed at Golden, Colo., to test the feasibility of gasifying low-rank fuels, such as lignite and subbituminous coal, in an externally heated metal retort.

Designed to gasify about 100 lb of raw lignite per hour or to make about 2500 cu ft of water gas per hr, this plant also was built to obtain additional technological information as a basis for designing similar large-scale units using steel or heat-resistant alloy reaction tubes. Based on results obtained in the operation of the plant from March to October 1944, the experiments agree substantially with previous laboratory deductions by proving that gasification can be controlled and relatively high capacity can be obtained.

The four-part progress report for 1944 describes separate phases of the cooperative work as follows: Carbonization and gasification of lignite in laboratory retorts; gasification of lignite in Glover-West retorts; gasification of lignite char briquets in a water-gas machine; and gasification of subbituminous coal and lignite in Golden, Colo., pilot plant.

Power Output

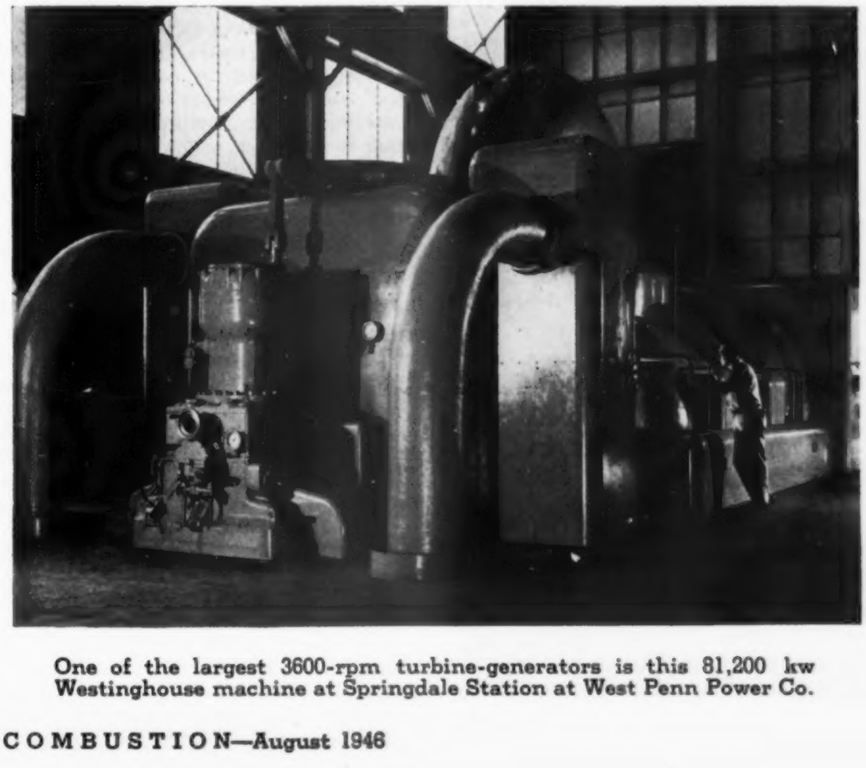
The Federal Power Commission, reporting on July 30, states that electric energy produced for public use in June 1946 totaled 17,621,480,000 kwhr, a decrease of 6.4 per cent compared with June 1945; and the combined electrical output of utilities and industrial establishments was 21,460,777,000 kwhr during the same period, a decrease of 6.7 per cent from June of last year. Production by water power amounted to 37.9 per cent of the total.

For the twelve months ending June 30, 1946, the production for public use was 212,895,099,000 kwhr and the total of utility and private output 258,343,962,000 kwhr. These figures represented decreases of 7.1 and 7.8 per cent, respectively, from those of the previous twelve-month period.

The greater decrease in the figures including output by industrial plants is as might be expected owing to peacetime load not having caught up with war production demand.

The report gives the capacity of generating plants in utility service, on June 30, 1946, as 50,160,191 kw, and a total industrial electrical generating capacity of 12,765,744 kw.

Electric operating revenues of the larger privately owned electric utilities in the United States were $263,347,000 in June 1946, an increase of approximately one per cent over June 1945. Net income was 18.5 per cent above that of June 1945.



One of the largest 3600-rpm turbine-generators is this 81,200 kw Westinghouse machine at Springdale Station at West Penn Power Co.

To Analyze Turbine Blade Deposits

Steam turbine plant operators in the industrial field are invited by the Allis-Chalmers Mfg. Co. to participate in a cooperative study to increase their power plant efficiency through an analysis of the nature and cause of costly turbine blade deposits. The plan for gathering data from turbine units operating in the field is part of an expanded research project being conducted by that company's water-conditioning and steam turbine departments. It is offering to analyze without charge or obligation steam turbine blade deposits from any make of turbine operating at throttle pressures of 350 psi or higher, provided samples of blade deposits are taken in accordance with certain recommended procedures.

For several years Allis-Chalmers' water conditioning department has been using the X-ray diffraction technique as an every-day tool in its laboratory analysis work. Because this technique affords a superior method for positive identification of the crystalline components in turbine blading deposits, it will be used to determine the types of compounds occurring in steam turbine blading deposits attributable to carryover and to correlate, if possible, the occurrence of several compounds with turbine stage temperatures, composition of the throttle steam and composition of the boiler water. The study is being limited to the several forms of silica and the sodium salts, since these seem to represent true carryover.

Pilot Atomic Power Plant

A pilot power plant employing nuclear energy is to be built at Oak Ridge, Tenn., the seat of the atomic bomb development. From such information as has been made available it would appear that the plant is being designed to operate on the conventional heat cycle, employing steam at common temperature level as the medium for electric generation, with nuclear energy taking the place of fuel. Obviously, much experimental work will be necessary before designs become final, particularly with reference to coping with radioactivity; hence it is anticipated that from two to three years may elapse before this pilot plant is in operation.

Consumption and Stocks of Coal

The Solid Fuels Administration reports the following distribution of bituminous coal consumed during the month of June 1946; also the stocks in the hands of various classes of consumers on July 1, 1946.

	Consumption, June tons	On hand, July 1 tons
Electric utilities	5,022,000	11,430,000
By-product coke ovens	6,267,000	3,629,000
Beehive coke ovens	531,000	....
Steel and rolling mills	582,000	624,000
Cement mills	575,000	482,000
Other industries	8,230,000	11,750,000
Railroads (Class 1)	8,274,000	7,297,000
Retail dealer deliveries	4,464,000	2,564,000
Total	33,945,000	37,776,000

From the foregoing it will be apparent that, based on June consumption the utilities are now better off as regards stocks on hand than any of the other consumer groups. These figures, of course, have no reference to individual consumers. While the total stocks in the hands of all classes of consumers were 19.4 per cent over the stockpiles of June 1, they are still considerably under normal as a result of the strike during April and May.

Atlantic Crossings by Steam

An editorial in our May issue, commenting upon the then recently observed National Maritime Day, mentioned this as being the 127th anniversary of the sailing of the steamship *Savannah* on the first successful crossing of the Atlantic by steam.

Noting this, one of our Canadian readers, Mr. Kenneth Moodie of Victoria, B. C., has written enclosing copy of an article by William Wood which appeared in the August 1933 issue of the *Canadian Geographical Journal.* This draws a fine point of distinction between the claims for the *Savannah* in 1819 and a Canadian vessel, the *Royal William* built in 1833.

From this it would appear that both vessels were equipped with sails to supplement steam and used both steam and wind power in crossing the Atlantic; but that the *Savannah,* owing to limited fuel-carrying capacity, was forced to rely upon sails alone for part of the crossing. On the other hand, the *Royal William,* with perhaps greater fuel-carrying capacity, used both steam and sails for the entire voyage; that is, she kept steam up all the way.

Assuming these to be the facts, which Mr. Wood substantiated by documentary evidence, it would be more correct to have referred to the *Savannah* as the first "steamship" to cross the Atlantic and the *Royal William* as the first such vessel to employ steam all the way in crossing the Atlantic. Both were regarded as steamships as it was not until many years later that auxiliary sails were discarded for vessels engaged in Atlantic service.

The one hundredth anniversary of the *Royal William*'s voyage, begun on August 3, 1833, was commemorated by the Canadian Post Office Department in 1933 through issuing a special stamp.

We are indebted to Mr. Moodie for bringing this historical information to our attention—EDITOR.

Electrical Engineering Exposition

An Electrical Engineering Exposition will be held in New York, January 27 to 31 next, concurrently with the Winter Convention of the American Institute of Electrical Engineers. This exposition, originally projected in 1941, was postponed because of the war, and is to be staged in the 71st Regiment Armory, at Park Avenue and 34 Street. It will cover late developments in electrical equipment for the generation, transmission, distribution and utilization of electrical energy, and should appeal especially to engineers and operating men who are responsible for the design, construction and operation of large electrical installations.

Management of the Exposition is under the direction of the International Exposition Company, which has been organizing and managing industrial expositions for thirty-five years, and is responsible for such established institutions as the Exposition of Chemical Industries, the forthcoming 17th National Exposition of Power and Mechanical Engineering, the 7th International Heating and Ventilating Exposition, and others. Associated with the management in developing plans for the Electrical Exposition is an advisory committee consisting of J. T. Barron, vice president, Public Service Electric & Gas Co.; Walter S. Finlay, Jr., vice president, J. G. White Engineering Corporation; E. S. Fitz, general manager, Electrical Department, Virginia Electric & Power Co.; N. E. Funk, vice president, Philadelphia Electric Co.; C. W. Leihy, *Electric Light & Power;* A. L. Penniman, Jr., general superintendent, Consolidated Gas, Electric Light & Power Company, of Baltimore; W. A. Perry, assistant to general superintendent, Inland Steel Co.; R. C. Roe, Burns & Roe, Inc.; Charles F. Roth, president, International Exposition Co.; E. K. Stevens, manager, Exposition; R. W. Wilbraham, chief electrical engineer, United Engineers & Constructors, Inc.; and S. B. Williams, Editor of *Electrical World.*

Personals

Alexander W. Luce has resigned from The Fellows Gear Shaper Company of Springfield, Vt., to become head of the Department of Mechanical Engineering at Pratt Institute, Brooklyn, N. Y. Prior to taking up war production work at Springfield, Professor Luce was head of the Mechanical Engineering Department at the University of Connecticut, and before that taught at Lehigh University.

E. D. Benton, formerly fuels engineer with the Louisville & Nashville Railroad, has been named to the staff of Battelle Memorial Institute where he will engage in research on the utilization of fuels in locomotives.

Lt. Commander J. G. Miller, after serving the past four years in the Bureau of Ships, U. S. Navy Dept., has lately joined the staff of Gilbert Associates at Reading,

Pa. For six years prior to his naval assignment he was with The Detroit Edison Company.

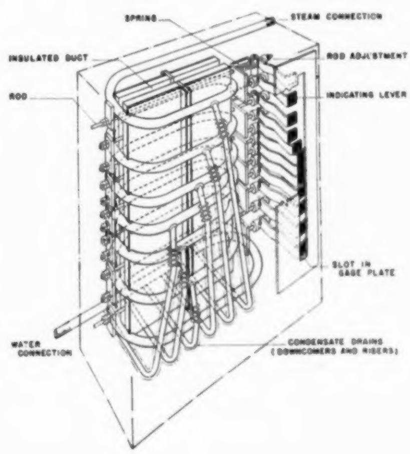
Richard L. Anthony has left the College of Engineering at Rutgers University to become associated with Westcott & Mapes, consulting engineers of New Haven, Conn.

W. J. King has been appointed Director of the Sibley School of Mechanical Engineering at Cornell University, succeeding Prof. W. N. Barnard, who recently retired.

Water-Level Indicator

The sketch shows a form of water-level indicator devised by E. Knautz and differing radically from the more conventional types.

It consists essentially of a coiled pipe, serving as a thermostat, the upper end connected to the steam space and the lower end to the water space of the drum. The coil is divided into increments to each of which is attached a rod that actuates a hinged indicating lever the far end of which is painted and bent facing the slot of the gage plate. Each rod is in adjustable tension against a spring, and since the rods are enclosed in a duct they remain at uniform temperature.



The vertical pipes, connecting each loop with the bottom, represent a combination of condensate drains, downcomers and risers. They are finned and the water inside the coil is always relatively cool. Steam in the upper portion of the coil will cause it to expand and remove the ends of the indicating levers from the slot, whereas that portion of the coil containing water will cause the indicating levers to cover the slot.

A suggested alternate is to paint the bent indicating lever ends two contrasting colors, and by suitably adjusting the rod tensions to make the steam portion show up in one color and the water level in the other color in the slot. It could be adapted to remote indication by employment of micro-switches and lights.

REVIEW OF NEW BOOKS

Any of the books here reviewed may be secured through Combustion Publishing Company, Inc., 200 Madison Ave., N. Y.

Water Treatment and Purification, Second Edition, 1946

By William J. Ryan

The first edition of this book appeared in 1937, since which time considerable advancement has been made in water treatment and new or improved processes have been developed. The present edition attempts to bring the reader up to date on such progress. The author who is associated with the Water Service Laboratories, New York, has supplemented his seventeen years' experience in the field with information contained in various papers before engineering societies and the technical press.

The text includes chapters on: impurities in water; sedimentation and coagulation; filtration; analysis of water; lime and soda-ash process; ion exchangers; boiler feedwater treatment; disinfection of water; tastes and odors; miscellaneous treatments; and the prevention of corrosion. A general appendix contains tables of equivalents, conversion factors, atomic weights, compound formulas, and the more common chemical reactions associated with water treatment. Typical process equipment is illustrated.

For plant engineers and plant operators the value of the book lies in the fact that the author has succeeded, in the space of 270 pages, in presenting the essentials of water treatment and purification, and in a readily understandable form. No attempt has been made to go into the details of processes, nor to discuss special or involved cases; but for the benefit of those who may care to delve further into particulars, a selected bibliography is appended to each chapter, containing references to technical literature pertaining to the various subjects touched upon in the chapter.

It should be understood that the book is not written for the chemist or water specialist, but rather for the engineer who needs a general knowledge of the subject in order to comprehend water problems and to review intelligently reports on such matters. This applies especially to feedwater treatment, ion exchangers and corrosion, to which considerable space is given.

The price of the book is $2.75.

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Steam Power Plant Auxiliaries and Accessories

This is a second edition (1946) revised by D. J. Duffin, of a book by Terrell Croft which is intended to serve as a practical manual for quick help in selecting, installing, operating and maintaining power plant auxiliaries. This edition, containing 12 divisions totaling 583 pages and profusely illustrated, has been entirely revised and reset to conform to the many changes that have taken place since the first writing (1922) although the general character and scope of the original have been preserved. An appendix of useful tables and data has also been added.

Evaporators, deaerators, air preheaters, piping maintenance, certain types of pumps, specific speed, cavitation, motor applications and a few other topics are discussed for the first time in this edition. The present tendency toward higher pressures and temperatures and its effect upon plant design and operation has been considered. Also incorporated are recent recommendations of the American Standards Association and the American Society of Mechanical Engineers as embodied in the various codes for boilers and pressure piping. A considerable amount of the earlier material has been left intact, since certain fundamental theory has not changed appreciably in the last 24 years.

The first three divisions are devoted to pumps, starting with a brief survey of the various classes and types together with the theory and calculations that apply. Many illustrations, descriptions and performance characteristics of reciprocating, centrifugal and impeller type pumps are given as well as the economies of selection of the various types. A section on pump management should prove of interest, as well as a treatment of the troubles associated with older types of pumps, many of which may still be in service.

A short division on injectors is followed by one on methods of boiler feeding including discussions on pump governors and feedwater regulators.

Division 6 is devoted to feedwater heaters, deaerators and evaporators. Included are some general rules for selecting exhaust-steam feedwater heaters together with a discussion of the economies involved as well as rules for the installation and operation. The association of evaporators with plant heat balance is discussed.

The remainder of the book is devoted to economizers, air preheaters, jet and surface-type steam condensers together with the pumps and ejectors used, spray ponds and cooling towers, steam piping, steam separators and traps.

Many illustrations and descriptions of numerous types and the selection and operation of the equipment are included. The division on piping includes descriptions of pipe fittings, flanges, expansion joints and hangers plus sections on heat losses and piping maintenance.

The price of the book is $5.00.

NEW CATALOGS AND BULLETINS

Any of these publications will be sent on request

Chemical Proportioning Equipment

%Proportioneers, Inc.% has issued Bulletin No. 1714 describing "Packaged Units" for constant rate chemical feeding and automatic flow responsive water treatment equipment for sea-going service.

Two bulletins (Nos. 242 and 246) describing Wilson Pulsafeeder chemical proportioning pumps have been issued by the Process Equipment Division of the Lapp Insulator Company. Complete details of construction and typical applications are included.

Deaerators

A 20-page booklet (Publication 4160) describing atomizing deaerators has been issued by the Cochrane Corporation. The atomizing type of deaerator does not replace the tray type but is particularly adapted to handle corrosive and partially softened water. Complete technical details and application data are contained in the bulletin.

Evaporators

A new, 12-page catalog illustrating the "Conseco" line of low-pressure evaporators and distillers for various industrial and marine applications has been published by Condenser Service and Engineering Company. As a guide for the selection of distilling equipment it discusses types of evaporator plants, advantages of low-pressure submerged tube evaporators and single and multiple effect units. Several good installation photographs and line drawings are included.

Pumps

Carver Pump Company of Muscatine, Iowa, has issued an 8-page bulletin, No. 200, describing a new line of centrifugal pumps ranging in capacity from 40 to 900 gpm and for heads up to 200 ft or higher. Included are details of the hydraulic design which the manufacturer says results in higher pumping efficiency for all classes of general service—efficiencies well in excess of 80 per cent for pumps as small as $2^1/_2$".

Pyrometer Supplies

The Brown Instrument Company has issued a 40-page Buyers' Guide (No. 100-1) on standard pyrometer supplies. The contents include clear and concise information on how to order thermocouples, protecting tubes, thermocouple wire, lead wire, insulators, etc., for application in all industries.

Steam Jet Air Ejectors

A new catalog issued by Condenser Service & Engineering Company, illustrates its line of "Conseco" steam jet air ejectors, and shows various applications for power plant, industrial, and marine use. It contains engineering data, specifications, graphs and tables to help the engineer select suitable equipment.

Synchronous Motors

Electric Machinery Mfg. Company has published a 24-page booklet (Publication No. 1068), "Selection and Application of Synchronous Motors and Synchronous-Motor Control." This is a comprehensive treatment in simple language of operating characteristics, power factor, torques, flywheel effect, speeds, excitation, starting kva, braking, motor protection, and five principal types of control, with some fundamental considerations of cost.

Two-Stage Pumps

Ingersoll-Rand Company has published a new 16-page catalog (Form 7062) entitled "Two-Stage Centrifugal Pumps" covering the construction and performance of these pumps. Designated Class GT, the pumps described are offered for general use in a wide variety of industries as well as for feedwater service for boiler pressures from 100 to 300 lb. The pumps are 2-stage, ball-bearing units designed to operate at modern motor, turbine and engine speeds; they are available in capacities up to 2200 gpm and for discharge heads up to 1050 ft. Included are cutaway views, types of drive and typical installations, tables of performance, dimensions and pipe friction and a typical pumping problem is worked out in detail.

Water Level Control

Bulletin 455, "Controlling Water Level on Combustion Engineering Type VU Boiler" by the Northern Equipment Company describes close stabilization of water level permitting a New England utility to operate a C-E boiler at high efficiency despite a cycle of operation which includes a dead shutdown for eight to fourteen hours each night.

Heads Chinese Engineers

Mr. C. Yun, Director of the National Resources Commission of China in this country has been elected president of the Chinese Institute of Engineers in the United States succeeding Mr. T. Y. Lu.

The Institute is a very active group and now has a membership of approximately a thousand engineers who are training or working in the United States.

In the accompanying photograph Mr. Yun is shown addressing the engineers at their recent convention.

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